THE INSTITUTION OF PRODUCTION ENGINEERS

THE USE OF AUXILIARY POWER ON MACHINE TOOLS

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IN course of development to meet modern requirements, machine tools have changed greatly from the not far distant days when a belt from an overhead shaft provided power, and incidental movement of the parts was made by the operator. Nowadays almost every natural means of power transmission is called into use. The use of electricity has extended vastly beyond the mere provision of an electric motor as a substitute for a belt, and has extended so far that there are several cases where photocells with radio amplification are brought into use.

Another form of auxiliary power which has made for itself a definite place in certain lines is that which we call hydraulic transmission, but the technique of its use is so very different from what is conceived by the word " hydraulics " that it has even ceased to use water as the liquid medium.

Compressed air is also quite extensively used in the field for which it has been found particularly suitable, and is, I believe, the auxiliary power which has contributed most to the reduction of physical effort of the operator.

Auxiliary Electric Power.

Before going into detail, I should like to point out that in this particular field there has been a degree of co-operation between the machine tool maker and the electrical apparatus manufacturer, which has contributed very greatly to the present harmonious combination, as seen in the best electrically-operated machine tools.

The machine tool maker has been prepared to give consideration to, and to make suitable arrangements for, meeting the requirements of electrical operation, and the maker of electrical apparatus has had to appreciate and provide for the more strenuous and much more frequent operation of the apparatus than was the case in early motor-driven machine tools, where very few stops and starts of the motor per day had to be provided for.

This collaboration has not only produced a better combination of the two elements, but has led to an application of ingenuity, and

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analysis of conditions, which has resulted in a continuous and successful development in the application of electrical operation to machine tool

Largely due to the national polyphase grid, the squirrel cage motor, which is probably the most rugged and trouble-free of all electric motors, has encouraged the adoption of individual motors to drive the various parts of machine tools, not only the spindles or main drives, but also many other movements occurring in the normal operation of the machine.

There are several advantages in this, first and most obvious being the avoidance of long and elaborate transmission members, as the squirrel-cage motor can be located close to the place where its power is required, but more important than this economy in transmission gear, is the avoidance of friction clutches, dog clutches, and the heavy efforts necessary to operate them, and the replacing of these by the stopping and starting and reversing of these motors, using as control the movement of easily operated switches.

This not only cuts out the clutch elaborations, but it actually benefits the life of the machine by providing a much gentler action in stopping and starting than was the case when clutches were used. This means longer life and less maintenance and replacement troubles in the mechanical part of the machine.

It is also convenient to fit ampere meters on such machines, so that their operation is under constant observation, as well as such safety devices as will cut off all current and stop the machines when serious overload occurs.

It must not be presumed, as seems sometimes to be the case, that the reduction of mechanical maintenance expenses is pure gain, as the electric control gear will absorb some portion of the saving, but nowadays, when switchgear can be provided to meet the actual conditions of service in the machine tool, maintenance interruptions need not often occur, and it is generally much easier to replace a small part of the electric control gear than it is to open up the machine for some mechanical replacement. It is also much more feasible to keep spares of such parts as contact fingers and coils and fuses, which are most liable to require replacement, so that maintenance is not abolished, but only shifted, and a similarly technically responsible person should also be provided to deal with electrical maintenance matters as was previously provided for the repair and maintenance of machines and plant generally.

The gain in operation well repays any disturbance of maintenance service in this way, by giving longer machine life, and by causing the idle movements of the machine to be made at speeds which it would be impossible for a human operator to maintain.

In the field of electrical operation it would be advantageous to the user if he could take up the position of collaborator with the

machine tool maker and electrical engineer. By providing suitable maintenance service, he could do this with advantage to his own production and to the progress of machine tool development.

Hydraulic Auxiliary Power.

This title appears at first glance rather strange, as hydraulic movement of the slides has become so common in, say, grinding machines, as to be regarded as a natural part of the machine. But the use of fluid pressure to produce a certain cycle of slide movements calls for a quite separate part of the machine from the normal driving of the cutter spindle, or its equivalent. Hydraulic transmission, using oil as a medium, is particularly suitable where movements at a moderate or very slow speed are required, but which involve considerable force. For example, in grinding machines only moderate forces are required, but traverse rates are fairly high. On the other hand, in drilling machines and boring machines, part of the movements are usually fast but of moderate force, and, whilst during the actual cutting operation the rate of travel must be slow and as regular as possible, the force may be very great.

The convenience of the hydraulic transmission is that it can be led anywhere by pipes, instead of shafts and gears, and can be manipulated by valves of very simple form to give a great variety of cycles of movement. It is always gentle, is not subject to shock loads, the mechanism can be very efficiently protected by the use of simple spring-loaded relief valves, and the condition under which the machine is working can be indicated by a suitable pressure gauge.

It appears from a cursory glance that the use of hydraulic transmission would be very simple, but one learns that this is not quite the case. The use of pressure oil, and the design of a suitable mechanism, has now reached a fairly advanced state, and in this connection the technique has been developed which has very little relation to the technique of water hydraulics used years ago.

In the case of hydraulic transmission, as previously argued in the case of electrical auxiliary power, the advantages provided have to be at least partially paid for by suitable maintenance, and the necessity of the maintenance personnel knowing something of the limitations and requirements of pressure oil transmission and utilisation is quite as important as the knowledge of electric operation previously mentioned

It is a general experience, however, that with hydraulically-operated machine tool movements, replacements are much less frequently necessary than with electrical apparatus, because the moving parts of the hydraulic mechanisms actually operate in oil, and though enormous pressures are controlled, the actual internal forces act in such a way as not to produce heavy rubbing pressures

on the parts of the hydraulic mechanisms. For instance, the control of the hydraulic circuit is practically always by means of piston valves which, though controlling heavy pressures, are themselves fully balanced, and are subject to very little wear

The chief points to be looked after are quite simple, and consist in keeping the machine fully supplied with the grade of oil specified by the maker of the machine, keeping this oil clean, and possibly the necessity of occasionally releasing air from the hydraulic circuit, if this is not provided for automatically.

Compressed Air.

I have referred in the early part of my paper to the beneficial effect of these auxiliary movements upon the operator by relieving him of much hard work. If the work of the operator is analised, it can readily be separated into general movements requiring moderate efforts, and rather savage efforts, which put a sudden strain upon the whole muscular system of the operator. Such movements are liable to be injurious to the operator by causing overstrain and physical injury, and it is in this field particularly that compressed air has come to his aid. For instance, the operation of gripping a workpiece in a chuck comes definitely into this class, and it is here that compressed air has met with its most general acceptance.

When compressed air is admitted to an air cylinder, it has at first very little resistance to overcome, and, being elastic, it starts the pistons into movement very quickly, so that the chuck jaws or other gripping members, when they meet the work, receive something in the nature of a hammer blow from the quickly-moving piston, an effect very similar to the slamming and heavy turning effort applied by the operator normally to the chucking lever or wrench. The compressed air also has in this connection the great advantage that its action is fairly regular from piece to piece, and it can be regulated to give the necessary gripping force, and to avoid excessive force, which is liable to occur if the operator with the wrench happens to feel particularly energetic.

Compressed air for this type of service is used for many other purposes than closing a chuck for a turning operation, and though its range of application does not extend very much outside this field, it is nowadays regarded as an essential adjunct in many types of operation.

The economical and proper use of compressed air involves, however, more than merely opening and closing a valve, and control systems are now available by which air pressure can be reduced for the finishing operations, so as to reduce distortion of the workpiece. Also provision is made for avoiding the possibility of air pressure fall causing accident, or at any rate arranging for an undue fall in

air pressure to give a visible or audible warning of this approaching danger.

Maintenance in the case of compressed air application is particularly simple, and, if provisions are made for supplying dry air and for occasionally injecting lubricant into the cylinder are provided, replacements amount to practically nothing.

Summing up, I think it can be stated that recent years have shown increased collaboration on the part of the machine tool builder and the specialist in the various fields of auxiliary power which have been adopted, and that the degree of co-operation has been a measure of the success achieved.

Production engineers have shown appreciation of the amplified production and quality of work achievable with these auxiliaries, and have in general accepted the implications of increased maintenance responsibilities. But I feel that it is the pace at which the user can become accustomed to, and conversant with, these developments, which is the factor that really controls the pace of development. It is, therefore, to the advantage of production engineers to make this contribution to the development of machine tools, in respect to the use of auxiliary power, not only in the directions to which I have referred, but in other directions which are from time to time found to be advantageous.

LIST OF LANTERN SLIDES

No.	*Machine*	*Maker*	*Illustrating*
1.	Multiple spindle drilling machine.	Archdale.	Advantageous location of motors.
2.	Plano miller.	Kendal & Gent.	Independent motors to each spindle.
3.	Plano miller.	Kendal & Gent.	Close-up of a spindle head.
4.	Plano miller.	Kendal & Gent.	Convenient controls, mechanical and electrical.
5.	Multiple drilling machine.	Archdale.	Grouping of motors on angular machine.
6.	High speed lathe.	Magdeburg.	Flanged motor, and gears in base.
7.	High speed lathe.	Magdeburg.	Location of electrical control.
8.	Large lathe.	Craven.	Quick traverse and feed motor on carriage, no long shafts.
9.	Deep hole drill. machine.	Archdale.	Three motors, spindle, auto cycle, pump.
10.	Deep hole drill. machine.	Archdale.	Auto cycle motor and electrical cabinet.
11.	Special vertical miller.	Archdale.	Table has special rectangular cycle by separate motor.
12.	Traversing head miller.	Archdale.	Separate motors for spindle, feed, quick traverse.

No.	*Machine*	*Maker*	*Illustrating*
13.	Special drilling machine.	Archdale.	Motor to spindle and auto quick traverse.
14.	Ingot milling machine.	Craven.	Table has both milling feed rate and planing rate.
15.	Roll grinding machine.	Craven.	All electric control gear on carriage.
16.	Deep hole boring machine.	Craven.	Feed and quick traverse motor located at end of bed.
17.	Large lathe.	Noble & Lund Igranic.	Control gears located at operative position on carriage.
18.	Plano milling machine.	Kendal & Gent.	Location of feed motor and gear box.
19.	Milling machine.	Klockner.	Comparison of mechanical and electrical machines
20.	Milling machine.	Klockner.	Example of milling machine largely electrically controlled. (Based on slide 19).
21.	Milling machine.	Archdale.	With electric quick traverse at 400 in. per minute to table.
22.	Large manufacturing miller.	Archdale.	General view showing control switches.
23.	Large manufacturing miller.	Archdale.	Close up of control switches.
24.	Large manufacturing miller.	Archdale.	Trip dogs for auto cycle carried on disc well protected against swarf and coolant.
25.	Circular table attachment.	Kendal & Gent.	With self-contained motor, no long transmission shafts.
26.	Cam milling attachment.	Herbert.	With self-contained motor, no long transmission shafts.
27.	High speed drill'g attachment on capstan lathe.	Herbert.	Self-contained motor avoids much transmission gear.
28.	Vertical milling machine.	Klockner.	Complete electrical control of motors and directions. and auto tripping of same.
29.	Unit electric drum, Sw for building in.	Klockner.	Durable construction, neat appearance, compactness.
30.	Complete electrical panel for building in.	Klockner.	Durable construction, neat appearance, compactness.
31.	Large lathe (rear view).	Noble & Lund Igranic.	Shows collector wires on long bed, and neat housing of electric gear in rear of headstock.
32.	Large lathe (rear view).	Noble & Lund Igranic.	Close-up of electric cabinet, open.
33.	Large plano milling machine.	Noble & Lund Igranic.	Accessible housing of electrical gears.

No.	*Machine*	*Maker*	*Illustrating*
34.	Six-spindle cyl. boring machine.	Archdale.	All movements hydraulic except spindle drive.
35.	Special milling machine for clutch pressure plates.	Archdale.	A complex cycle of movements all hydraulically operated and fully interlocked.
36.	Special milling machine for clutch pressure plates.	Archdale.	Close up of work fixture and cutter spindle head.
37.	Special milling machine for clutch pressure plates. (Rear view).	Archdale.	Shows hydraulic gear and cycle control valves.
38.	Deep hole drill.	Archdale.	Has automatic intermittent feed cycle and separate electric panel, electric control of hydraulic cycle.
39.	Capstan lathe with air chuck.	Herbert.	Convenicnet location of chuck control.
40.	Capstan lathe with air chuck. (Close-up).	Herbert.	All necessary functions of air control built into "Monoblock."
41.	Machine vise, air operated.	Herbert.	Gives regular action without "operator strain."

Discussion

MR. R. C. FENTON: About the application of electricity to machine tools, there is one thing that has struck me in a number of recent designs, and that is the large amount of floor space occupied by control cabinets. I was fortunately able to go over to the Leipzig Fair this year and I noticed over there two or three machines which had obviously been built to get round the patent rights of other manufacturers. In the case of a very large lathe on one stand it was not so apparent, but when I went over to see a similar application on another machine which was quite small, to my amazement they had exactly the same electrical gear and electrical cabinet for the smaller machine as for the large one. When I tell you these cabinets were about 4 ft. 9 in. high by 2 ft. deep by 9 ft. long, you can see that there was some floor space occupied, on the other hand we come to some of the illustrations Mr. Wright showed us, of the Klockner switchgear, which certainly appeals a great deal more to us in its accessibility and the amount of room it occupies. I should like to ask Mr. Wright one question—Where this switchgear is supplied, and the electric appliances are put on machine tools using a rather copious supply of coolant, is any trouble experienced with coolant getting into the electric connections and affecting the electrical wiring?

MR. WRIGHT: Floor space, of course, depends on the complexity of the operation. If you are using some very refined functions of electricity which a machine tool maker may not understand, then you are entirely in the hands of the electrical people, and that means that they give you a cabinet as big as you can possibly have. That occurs only in elaborate cases. The examples Mr. Fenton saw at Leipzig of nicely housed electrical gear are favourable to the saving of floor space. Where the scheme is fairly simple and practical, no increase of floor space is necessary. I have been dealing quite recently with a small milling machine with rather elaborate electrical equipment, and I could not find room for this in the upper part of the column, but I succeeded in making plenty of room for all the electrical gear without increasing the floor space at all.

With regard to coolant, that has been a trouble and is a very big trouble yet. You cannot keep coolant out of a milling machine, or out of the carriage and its gears on a lathe. On many machines where the work and coolant are above the slides and mechanism, you cannot keep coolant out. I have been trying for forty years and have not done it, but I am keeping on. People will say, if you will only put a little groove here or there, that will do it, but you cannot keep it out. The best thing is to see that the water, if it

gets in, won't do any harm, and the two most likely things there are, first, to have all control circuits, which are the circuits that go into the machine and near the suds, of very low voltage, and then it does not matter if the switches are wet or not; to every switch you have to have wires, of course. Then you keep the wires as dry as you can, out of any strong coolant and suds, and you string them all as full as they will go with glass beads; do not use indiarubber as a conduit, it will perish in the suds and oil. Even then I would not guarantee that you will never have trouble, but it is worth while doing your best. The biggest contribution you can make is to use very low voltage on all of your control circuits. It simply means that the contactors have got to have special coils wound to operate on the low voltage. It costs no more, and there is no difficulty about getting it done.

MR. E. T. COOK: My experience in connection with the use of electric drives to production apparatus does not lie in the direction of machine tools, but I rather fancy that they do not necessarily get the best electrical gear for the job. The electric motor to-day is, as Mr. Wright has already stated, a very remarkable piece of foolproof gear, but when we go on to elaborate switches and fuses and that sort of thing, I do not think that electrical engineers who apply their knowledge to the particular question of control make sufficient use of really modern knowledge in connection with switches. I will quote one very simple case. In some experiments made recently in connection with control of 5 h.p. motors, I found that a very practical switch could be made for interrupting the circuit from a motor on A.C. by merely separating the contacts a distance of about .010 in. I do not know if that kind of principle is to-day applied on machine tools?

These controller drums that Mr. Wright showed, I too had noticed in the Leipzig Fair, and in my opinion they are quite unnecessary. I suggest, with all due deference, that Mr. Wright calls on his electrical engineer to cut out a lot of this elaboration and space and expense and begin to achieve the same degree of efficiency as the motor manufacturer. I am sure it can be done. I speak from a little knowledge in that field of the electrical industry. There is just one other point. The enormous saving of expense which must result from the application of electrical drives does not seem to be particularly reflected in the price when we buy these machines.

MR. WRIGHT: Mr. Cook has suggested that we get the gear we deserve. We try to deserve the best by discussing quite openly the operation of machines with the electrical engineer. As I said, there is a very agreeable degree of co-operation now in the working out of electrical schemes between the supplier of electrical apparatus and the builder of machines. The frequency of breaking circuit, the operation of switches, whether these switches actually have to

break the starting current of a squirrel cage motor, or whether they only have to break the running current—a lot of considerations like that, are fully specified and tabulated before the electrical engineer starts. We do not like the electrical engineer to say that our spindles on our milling machines are much too big, and tables are too big or not big enough, and therefore we gracefully do not tell them what switches are required and so on. I had to do with remote control electrical switchgear many years ago, in another existence, and I know that the opening of contacts and that sort of thing is very much greater than it has any need to be with alternating current. These probably persist as traditional practice from the old D.C. days, when you had to have a big gap, but nowadays it should be possible to use very much smaller gaps.

Another thing in connection with low voltage control circuits that I mentioned, is that a .010 in. opening of switch on one of the limit switches is quite sufficient. In fact, the thing stops long before you have opened it .010 in., but if it happens to work near moisture, you had better make it .015 in. It will still do its job, and you want to protect it against being shorted by moisture. Though we may respectfully suggest to the electrical people that they should give us smaller gaps, we still have to leave the electro-technicians to decide.

I have actually a case on now where I wanted a solenoid to exert a very small force with a very small movement. I sent an inquiry giving the fullest particulars to a prominent electrical supplier, and in the interval, in order that I could get on with the scheme, I designed a solenoid myself to do this job. The solenoid the electrical people offered was 9 in. by 5 in. by 4 in., that was the volume that it occupied. The solenoid that I designed was 2 in. in diameter and 2½ in. long, to do the same job. I shall now have to see the technical man of this firm and get them to make me something like my design, as small as I have asked for, very much less than the one they originally offered out of their catalogue.

Mr. Cook also said that electrical simplicity is not reflected in the price. It has been mentioned before—I think I have used the argument more than once—that when a new line of machines is developed there is a great deal of expense that has to be covered in the first 100 or 200 machines which amounts to quite an addition to each of these machines. In fact, when you design a machine with drastic new parts in it you can say that when that machine is running it costs four or five times as much as the machine will cost in two or three years when you have got down to batch production. The extra cost for the development and experiment has got to come out of the consumer in the end, so the machine is as costly as before, though it looks to have less in it. This goes, for some time, until some other people come in after three or four years and copy it at

£50 less, and you have got to come down. But don't you wait for that! Have the machine in the early years and get the benefit of it!

MR. BUTLER: One question has worried me for some time, that is, the immense diversity of types of switch with which the operator is called upon to become familiar. There is no perceptible tendency to standardise any particular type of electric switch on operating gear, push buttons, turn buttons, lever controls. Mr. Wright showed us a very ingenious lever on a milling machine which pushes left or right to move a table in or out of the feed or idle speed. That seems to me to point the direction that switchgear control should take on machine tools. The operator in a hurry may not be able to find which button of a row is the one he wants. Perhaps Mr. Wright could tell us a little more about that.

MR. WRIGHT: One of the things that one keeps in mind in designing a machine which is avowedly going to be largely electrified is that the normal manipulating movement should be by a lever differing very little from the lever on a mechanical machine, so that the operator does not, in an emergency, have to think of a little red button round the back, but grabs a lever and stops or reverses the machine as the case may require.

The apparent number of turn buttons and things of that kind about the machine are not things which can be used in an emergency, and they are only substitutes for lever-selective movements. On the big milling machine, one of the operations in setting up the job is to engage the particular feed direction you are going to require, table feed or cross feed or vertical feed. You have to select your movement which is going to come into action. On the ordinary mechanical machine you do that by means of a lever which may be a turn button. On the electrical machine you probably do that by a definite turn button switch, thereby working the switch into one of three positions. You only know that you are operating the switch; you might equally be operating some mechanical change as well, and often are doing so.

The vertical miller I showed you which had three positions, that gives you three different electric circuits. The shaft of the switch is continued forward and changes the mechanical connections as required.

The object, as I said at the beginning, with any machine designed for general electric operation is to keep the mechanical operating functions as uniform with ordinary practice as you possibly can, and only use turn buttons and selector switches with those things which are done deliberately and according to some instruction or planning sheet, or something of that kind, for the particular job.

I understood Mr. Butler to support Mr. Cook also in relation to the use of switches. He said something about the great variety of switches. The big electrical firms, and many of the little ones,

make it their business, and base all their propaganda on their switch or gear being in some particular respect a little superior to others. All the machine tool maker can do is to ally himself with a good reliable firm who make good reliable tackle, and to design his machines to take their electrical gear after due consultation and collaboration. That would be very nice if the machine tool maker were allowed to do it, but there are many cases where he cannot do it, where the purchaser of the machine tool must be consulted, and he may have decided he will only have Tom Jones' electrical switchgear in his works. That is very inconvenient if one switchgear is absolutely different in its dimensions from the other. The only thing is to put one of these panels outside in a cabinet which looks something like a war memorial, and hope for the best. That has to be done quite often.

MR. E. P. EDWARDS: While I have listened with very great interest to Mr. Wright's Paper, I am disappointed at his meagre reference to hydraulics. He started off very well indeed, and even showed a lot of slides on electric and air-operated gadgets and accessories, but apart from the early reference I have not heard very much more about hydraulics in the body of the Paper. I thought at one time that we had got to the point where we had converted Mr. Wright to 100% hydraulics, but he seems to have gone right back again to-night. I would have thought he would have told us how much easier it is to control things hydraulically and perhaps, hydro-electrically, performing movements, whether they be rotary or sliding, because either of them ultimately resolve themselves into power or speed. I know of no means of controlling power and speed so easily and so efficiently—much more efficiently than you can by electricity alone—than by hydraulics, and in using, say, a good modern fluid power pump you can use the same mechanism to operate accessories such as chuck-closing or clamping and similar requirements, but Mr. Wright has not mentioned any of these things.

MR. WRIGHT: If Mr. Edwards and I were alone and you gentlemen were not here, I should tell him that I agree. Hydraulics is, for a very large number of cases, superior to electricity for producing these movements, but what I personally think about it has very little to do with what is done! Propaganda has ruled in recent years that the elaboration of electrical gear is fashionable, and I have had to pay more attention to it.

Six or seven years ago we were not doing quite so much in the electrical line. Hydraulic movement of all kinds was more fashionable. At that time the firm I am with were very directly employed on special production machinery which could be set up for a certain cycle of operations and which continued to perform that cycle as

long as it lasted, are still doing it, probably. An important consideration was the cost of production, but they were going into quantity production, having got that type of outlook that will allow them to buy—I won't say single-purpose machines—but special operation machines which could be set up for a certain cycle and be expected to go for a year on that particular cycle.

The tendency nowadays is to buy general purpose machines, the machines with which, if you are making motor-cars this week, you can be making bread-and-butter machines next week, you are not tied to one type of production to any great extent. In the last five years, which dates mostly from the big rush of motor-car production machinery, the demand has been for more general purpose machines. On general purpose machines, the idea that you are going to change jobs every few minutes is not so convenient on a hydraulic machine as it is on a screw-operated machine which involves some kind of rotary power, probably electric. But wherever possible, even of late, we make hydraulic machines for definite set cycles where the machine is going to be on that cycle for ever. They are not, however, as numerous nowadays as they were five or six years ago, and the great increase in machine tool production has been very much more in general purpose machines. Regarding ease of control and convenience of control, I perfectly agree that where you have hydraulic movement it gives you what you want to meet the requirements of work ; there is no doubt that hydraulic control is sweeter than electric. You may have a bit of a leak here and there, but it is much safer losing a little oil than a little electricity. You can see where it is in the case of the oil, but in the case of electricity it generally means a man on the floor and two fellows waving his arms about, before you know where you are !

On the question of producing a rotary motion by hydraulic means, that has been tried many times. Personally, I have never had anything to do with it. In every case where I have known it to be tried it has been discontinued. It may still be good ; there may be some possibility, but it does not appeal to me to produce a rotary motion when you have a rotary motion at the start. If the drive demands an infinitely variable speed (which is a very good thing if you can get it) then the probable disadvantages, whatever they are, of the hydraulic rotary drive would have to be faced, but I have not had anything to do with it and I do not know what those troubles are. It has not come forward as much as it would have done if it had been a really good thing.

Mr. Edwards also spoke about the use of hydraulics for chucks and vises. I think hydraulic gear is too gentle. You can get enormous forces, of course, but when you chuck a piece in a lathe chuck, the jaws of the chuck bite into the piece by the slamming that they get from the suddenness of action of the air cylinder, but after that,

in my opinion the loads involved in the bite do not actually continue ; the bite continues but the load settles down after the actual slamming, and for that reason you get a hold on the work which is large in proportion to the force you are exerting on the work. If you do that hydraulically, you do not get that kind of bite, and you would have to retain a higher pressure on the work all the time you are working by hydraulic operation than you do if you work by compressed air. That applies to any form of clamping. Clamping any piece involves putting a considerable force on the work by inducting a certain amount of spring of sufficient force to continue to hold the work. In my opinion, compressed air is the best kind of action for giving that grip, and hydraulics is altogether too gentle. That is my view. I have never actually tried hydraulics on chucking, but from knowing the way hydraulics work, I should hesitate about using hydraulics for a chuck closing operation.

MR. FENTON : There is one aspect that has not been mentioned, and that is with reference to the services which have to be fed to the machine itself. Mr. Wright mentioned a device of using low voltage supply for certain of the services on the machine tool. That necessitates a supply to the machine of that current. Then it is quite conceivable that the suds pump, for example, being small would probably require to be driven by 110 watt or 220 watt current. You may make use of a magnetic chuck requiring D.C. The main driving motor will quite possibly be a 400 or 500 watt, multi-phase supply. Then there is a pneumatic chuck requiring air supply. The whole of that means that there has got to be a considerable amount of equipment somewhere about the factory, and if some simplicity in that direction could be achieved I think it would be an advantage, particularly so in view of the fact that, as machines for mass quantities are sometimes moved to suit production conditions, there is a fair amount of mobility required in the machine tool itself.

MR. WRIGHT : Thank you, Mr. Fenton. You have brought up quite an interesting point. Presumably we have the local grid supply of 440 watts three phase available. If we have all the things I recommended, we require also any number of different low voltage transmissions. The remedy for that is one of these rather complicated looking electrical panels which I showed you. For ordinary machines, to produce low voltage you want a transformer, which will probably be about 5 in. cube, nothing bulky, which occupies little space, has no moving parts about it and is just as safe and durable as any other part of the machine. Then you require direct current for operating the magnetic chuck. That means a three-phase Westinghouse rectifier—you don't want a lot of current. That goes into the cabinet, providing a very durable and non-

wearing sort of instrument that goes on for a long time and simply wants space.

The electric pumps which one uses on machine tools are all three-phase pumps, and if you have the advantage of the three-phase circuit, 440 volts, that is quite feasible on a comparatively small pump. But the provision of this service does not involve any more working parts. It does involve a little more bulk in the electrical cabinet for pump protection. With regard to compressed air, unfortunately that is another lead that has got to come from somewhere to the machine. In addition to these three wires from the grid, the compressed air system adopted must be a good reliable one to avoid dangerous pressure falls. According to the reliability of these services, that is the three-wire supply, and the compressed air supply to the machine, will be the reliability of the machine in actual operation.

MR. R. H. YOUNGASH : The position, as I see it, amounts to this. We first started to apply electric motors to the driving of short lengths of line shaft, and from that this development of individual drives has gradually been evolved. So far as the application of electrical apparatus to the machines themselves is concerned, the magnetic chuck was about the first thing we had. It was largely used for grinding and frequently gave trouble, and even to-day there are difficulties, of which repair seems to be a greater problem than the mechanical repairs of old. I find I can get quite an amount of mechanical repairs done to a machine in less time than it takes me to find the electrician. The early electric machine was direct current, and very useful in this respect, that it was relatively easy to change the speed, and one of the drawbacks with the alternating current is the problem of varying the speed of motors.

Mr. Wright has already referred to something which I mentioned six or seven years ago, that is, the tendency to leave the specially constructed one-purpose machine out, and adopt a standardised machine which, with some variations, can be made adaptable either as a special machine or, more particularly, as a machine which could fairly readily be converted to do some other class of work. But you have one very grave difficulty, and that is this fixed speed of the electric motor, and in the case of individual machines, special machine tools, that fixity is a real difficulty because you cannot change from one class of material to another ; you cannot even meet comparatively small variations in hardness without in some cases having to provide new gears of slightly different ratio, and it is undoubtedly a real drawback in many cases.

From the gradual adoption of individual drives to machines, we have now progressed to a stage where we have different motors, each one controlling its own parts, and I do not personally see how

we can hope to have any sort of control over those without a considerable amount of electrical gear of some sort or another.

Mr. Wright has referred to an indiscretion on my part when I mentioned, some years ago, seven-valve sets. Probably it remains the same to-day. You have this inter-locking and imposing of one control on another. It is very difficult to see how one can avoid it and at the same time preserve any atmosphere of simplicity. In addition to that there is the difficulty of disposing of electric motors. They are festooned around machines in various devious and sometimes dubious positions where, as Mr. Fenton has already mentioned you get infiltration of cutting compound, oil, suds, swarf and a variety of undefined muck, all of which makes not only the cleaning of the machine difficult, not only the repairing and adjusting of it, but the dismantling of it. You have a lot of filthy material to dig out before you can even find the bolts.

Where belt drives are involved, the electric motor is placed near the base, and there is frequently difficulty through oil getting on to the belt. I do not know how far the machine tool designer can help us in that direction, but there is undoubtedly a real difficulty in points of that sort.

Compressed air is a very useful commodity, but it is one of the most expensive that we use. It should be used with great care, and yet if you go by a machine which has a compressed air movement, even if it is only a chuck, you will hear that air fizzing and blowing away while the operator remains blissfully unconscious of the fact that you are having to pay for coal, attendance, oil and such like. There is also another element one has to remember in this connection, that is, that there is a very considerable amount of danger to the operator where compressed air is concerned. And, of course, there is always present the difficulty of dry air. It is all very well glibly talking of dry air, but if you have an air compressor running perhaps, as we have miles away from the point, at very frequent intervals we have to put drains to keep taking the water and moisture out of the air, but in spite of that we are always experiencing parts rusting up, and there is the difficulty of inserting lubricating oil or anti-corrosive mixture of any sort into an air system and be sure that it is going to get spread all over the surface.

With regard to hydraulics, I do not propose to enter into any controversy, but I am going to say just one or two things about hydraulic systems, and that is, the pipes should be outside. Bringing the hydraulic pipes inside the machine is a great mistake, because they may be leaking slightly, and the application of a spanner would prevent that leakage. You cannot see them. You have to do quite a lot of dismantling to discover where they go, and you get conditions where the cutting oil and hydraulic oil are getting mixed. I say " mixed " in an opposite sense, because they do not mix.

We have a number of machines where we would like to use a water-base cutting compound, but we cannot because it gets into the hydraulic system, or the hydraulic oil gets into the cooling system, and one spoils the other. Control valves are also quite troublesome. You get some rather delicately made valves which will gum up and cause trouble, and there may be a lot of dismantling to do before you get to these valves. If they could be kept on the outside, easy of access, it would be of considerable benefit.

I think that over-elaboration is the thing that machine tool makers should guard against all the time. One really wonders whether some of the machine tool designers to-day are not looking round the machine and saying to themselves: "This is another place where I can stick on an electric motor; there is a place where I can put a pump, and here we can have compressed air . . ." and so on. Machine tools to-day are producing, per unit of floor space, or per pound of cost, or however you like to look at it, a greater amount of work with a smaller amount of labour, and in doing that you must remember that we have got to provide means that hitherto have been supplied by this most wonderful of all auxiliaries, human power, and we have now got to provide it by mechanical power, whether it is electrical or hydraulically operated. That is the direction in which we are getting the greatest amount of benefit. How far we shall go down this line, I do not know.

Some of these machines are getting really past belief in their uncanny mechanisms, and the uncanny way in which auxiliary movements are able to operate cycles is one which we could never have imitated so successfully by mechanical machines as we are able to do by electrical, hydraulic and compressed air movements.

MR. WRIGHT: I think that Mr. Youngash has cancelled out and so has made it unnecessary for me to reply to a lot of his comments.

All this complexity has been giving us advantages. You may think that this complexity is too complex for the advantage it has given us, but, if so, then you should be the designer and show us how to do it.

Mr. Youngash spoke about breakdowns and burnt out motors and that kind of thing. In the use of electrical apparatus on machine tools it is a very easy thing to provide safety protection for electrical machinery. There are all kinds of fuses, for overload, cut outs, and that kind of thing, available. Very interesting combinations are being used nowadays which, if we had still more time, I should enlarge on.

Mr. Youngash also spoke about D.C. current and change of speeds. He spoke about the standard special machine, that is, the machine which, though not a general production machine, can be widely altered in its particular application. A lot of machines of that

kind have been developed in the last ten or fifteen years, and those machines are still in some kind of demand. I spoke of a multiple drilling machine in which the drilling spindles are driven by universal jointed shafts, and you could arrange the spindles in different groups without very much cost. That machine is still in quite good demand.

I showed you a cylinder boring machine where the cylinder centres can be altered without very much trouble, so that a machine costing several hundred pounds could, with the expenditure of a hundred pounds, be made to suit quite a different arrangement. Mr. Youngash mentioned the desirability of being able to take a machine for one class of material and make a general change so that it is suitable for another material. One of the machines I showed had such a change, by slip change gears, for each material, in addition to a lever change speed gear giving several speeds in each field.

Mr. Youngash also spoke about twelve motors, and the proportional amount of electric gear. The electric gear on 12 motors would certainly be quite serious, but if those 12 motors were to perform the work which it would take three men to perform, it would be a paying proposition to have a cartload of electrical gear instead of three men, from the cost point of view. The interlocking certainly involves a complicated arrangement of wiring, but the method of drawing electrical wiring diagrams for machines is very simple and is easily understood by the kind of electricians we want on these machines. There is no great difficulty. We do not expect machine tools to be in the hands of the kind of people who use motor-cars, who cannot trace wires or anything else, but go to the nearest garage to get some one to do it for them. We want maintenance men capable of reading diagrams and understanding some of the complicated electric wiring and putting it in order quickly.

Mr. Youngash rather dropped a brick when he talked about having to scrape inches of grease and slime off everything when any repairs have to be done. The answer to that is that there should be a little cleaning done occasionally on the machine in between the three or four year period when repairs are done!

Mr. Youngash spoke very feelingly about the need for having the pipes of hydraulic gear external and accessible. I think in special hydraulic machines that are built one-off for some production job, you will find that electrical gear and piping are usually very accessible. But when a machine is designed for general production and a lot of time is spent on it to make a nice job, then the designers have time to conceal a lot of pipes and electrical gear in the machine in the interests of neatness, and they do so. Mr. Youngash does not agree. I do not myself, but the machines certainly look better. I showed you a complex sketch for a milling machine. The only criticism anybody makes about that machine is, " What a mass of

pipes ! " because all the pipes are accessible and visible, and there is quite a number of them on account of the interlocking I spoke about.

I sympathise and heartily agree with what Mr. Youngash said about the waste of compressed air. There is no doubt it is about the most costly service in the shop, and when you see blow guns in the fitting shops which are used for cleaning, lying on the floor and the air being wasted at the rate of 3d. a minute, it is very exasperating.

I do not think the object of machine tool makers in taking the advice of specialists in the details direction is with a view to being able to blame them. The machine tool maker gets what he really thinks is a reliable firm and then gives a good deal of respect to their suggestions and proposals, with a view on both sides to getting trouble-free machines. As I said in respect to general over-elaboration, we get advantages from it. This over-elaboration gives great advantage in production ; but it is not of advantage if we do not provide more technically capable maintenance to deal with the special services which have been introduced, as our contribution towards greater production.

INSTITUTION LUNCHEON

IN place of the Sixteenth Annual Dinner of the Institution, fixed for October 20, 1939, which had to be cancelled owing to the war, an Institution Luncheon was held at Grosvenor House, Park Lane, London, on Friday, November 17, 1939.

Prior to the Luncheon, members and guests were received by the President, Mr. G. E. Bailey, M.I.P.E., M.I.Mech.E. The attendance numbered 527. The speech of the Right Hon. Leslie Burgin, M.P., Minister of Supply, was broadcast by the British Broadcasting Corporation; all reports indicate that the broadcast reception was everywhere excellent, and was heard by a large number of members unable to attend the luncheon.

The Attendance.

ON THE PRESIDENT'S right were: THE RT. HON. LESLIE BURGIN, P.C., LL.D., M.P., *Ministry of Supply*; THE RT. HON. VISCOUNT NUFFIELD, O.B.E., F.R.S., M.A., D.C.L., LL.D., *Director General of Maintenance, Air Ministry, Retiring President;* THE HON. VINCENT MASSEY, *High Commissioner for Canada*; VICE-ADMIRAL SIR HAROLD A. BROWN, K.C.B., *Director General of Munitions Production, Ministry of Supply*; THE RT. HON. LORD ILIFFE; COMMANDANT MONOD, *French Mission, Ministry of Economic Warfare*; W. J. JORDAN, *High Commissioner for New Zealand*; SIR FIROZKHAN NOON, K.C.I.E., *High Commissioner for India*; SIR CLEMENT D. M. HINDLEY, K.C.I.E., M.A., *President, Institution of Civil Engineers*; M. ANTONI JAZDZEWSKI, *Counsellor of the Polish Embassy*; LIEUT. GENERAL SIR MAURICE TAYLOR, K.C.B., C.M.G., D.S.O., *Senior Military Adviser, Ministry of Supply*; JOHNSTONE WRIGHT, *President, Institution of Electrical Engineers*; C. le MAISTRE, C.B.E., *Director, British Standards Institution*; HAROLD BUTLER, *President, Machine Tool Trades Association*; A. A. ROWSE, *Controller of Machine Tools, Ministry of Supply*; J. D. SCAIFE, *Past-President*; T. FRASER, *Past Chairman of Council*; H. SCHOFIELD, M.B.E., Ph.D., *Principal, Loughborough College*; W. C. LUSK, *Managing Director Assd. Electrical Industries*; C. EDGAR ALLEN, *Editor, "Machinery"*; T. G. SPENCER, *Managing Director, Standards Telephones and Cables*; N. V. KIPPING, *President, London Section of the Institution*; F. G. LAWS, *President, Eastern Counties Section of the Institution.*

ON THE PRESIDENT'S left were: THE HON. T. A. CRERAR, *Minister of Mines and Natural Resources, Dominion of Canada*; THE RT. HON. LORD SEMPILL, A.F.C., *Deputy-President (and Past-President) of the Institution*; THE RT. HON. S. M. BRUCE, C.H.,

M.C., *High Commissioner for Australia*; MAJOR GENERAL A. E. DAVIDSON, C.B., D.S.O., *Controller, Mechanisation Department, Military Adviser, Ministry of Supply*; E. BRUCE BALL, *President, Institution of Mechanical Engineers*; SIR FELIX POLE, *Chairman, Associated Electrical Industries*; PERCY C. KIDNER, *President, Institution of Automobile Engineers*; C. N. MCLAREN, *Director General of Ordnance Factories, Ministry of Supply*; JAMES G. YOUNG, *Chairman of the Council of the Institution*; SIR FRANCIS CARNEGIE, *Chief Superintendent, Woolwich Arsenal*; G. S. WHITHAM, C.B.E., *Director of Ammunition Production, Ministry of Supply*; A. EWING, *Managing Director, Climax Rock Drill Co.*; P. H. MILLS, *Deputy Director of Ordnance Factories, Ministry of Supply*; O. BODEN, O.B.E., *Assistant Director General of Maintenance, Air Ministry*; E. GORDON ENGLAND, *Man. Dir., General Aircraft Co.*; DR. W. ABBOTT, *H.M. Inspector, Board of Education*; W. L. FISHER, *Past-President*; I. W. CHUBB, *Editor, "Machinist"*; C. J. BARTLETT, *Managing Dir. Vauxhall Motors*; H. S. SYRETT, C.B.E., LL.B., *Legal Adviser to the Institution*; H. A. HARTLEY, *Member of Council*; W. CORE, *President, Manchester Section of the Institution*; A. SYKES, *President, Yorkshire Section of the Institution*; J. W. WALKER, *President, Sheffield Section of the Institution* J. C. N. HUGHES, *T. G. Scott and Sons.*

In addition to the above, the attendance included the following :—

C. Ackerley, C. Adams, S. W. Alexander, F. Allen, F. J. Allen, W. W. Andrews, C. H. Appleby, J. E. Apted, F. S. Armitage, J. I. Armstrong, R. W. Asquith, J. Atherton, P. Attwood, L. Austin. A. J. Bailey, W. Bailey, S. Bant, N. Baliol Scott, W. J. Barber, Major T. M. Barlow, R. Barlow, H. M. Barns, — Barrett, G. P. Barrott, F. F. Batcheldor, F. H. Bates, H. Baume, H. J. Bavington, L. A. Beadle, E. Belcher, G. E. Bell, W. T. Bell, J. E. Bennett, J. W. Berry, Gilbert Berthiez, G. W. Betteridge, F. E. Bickley, J. H. Bingham, A. J. H. Binns, R. Black, J. E. Blackshaw, J. W. Blackshaw, S. F. Blanch, W. W. Bode, S. R. Bonney, S. Bottams, E. A. Bostock, D. Bowen, H. Bowley, A. L. J. Brain, A. J. Brain, H. Bright, A. Broadbent, W. Broadbent, Noel K. S. Brodribb, L. E. Broome, L. R. Broome, F. W. Brown, J. Harold Brown, L. H. Brown, D. Burgess, E. C. Burgess, J. W. Buchanan, S. A. Bunn, R. Burkett, T. P. N. Burness, W. E. Buskard, E. E. Butten, A. Butterworth. E. S. Cadden, C. Carnell, E. Carpenter, A. J. Carrat, J. J. Carter, S. Caselton, C. C. Castro, N. W. S. Catmur, T. S. Catmur, Colin Cavell, H. A. Chambers, P. E. Chatelain, G. H. Charman, T. A. Clapham, W. A. Clapham, E. S. Clark, T. Clark, C. A. Clarke, G. W. Clarke, S. A. Clodd, W. D. Colin-York, J. P. Coleman, H. W. Collier, H. C. Collins, — Collinson, C. B. Colston, A. H. Cooke,

INSTITUTION LUNCHEON, 17 November, 1939.

J. Colton, A. T. Coote, A. H. Copeland, H. Cottam, W. Cornell, R. W. Cotton, M. Crabbe, P. G. Crabbe, T. S. Crabtree, F. W. Cranmer, J. H. Crawford, W. A. Crewe, Dr. J. F. Crowley, J. W. Crowley, N. A. Cullin, F. Culpin, W. L. Custance, J. F. Cutts. A. W. Daniels, E. G. Davies, F. P. Davies, S. Davies, A. V. Dawson, F. Dawson, J. de Jong, Capt. T. Denness, H. W. Denny, G. C. Detlefsen, W. Dickson, W. E. Dilke, J. Dobson, H. J. Dodds, W. F. Dormer, H. A. Drane, P. Driver, A. Dunn, H. W. Dutton, B. H. Dyson. J. C. Eastes, E. P. Edwards, J. H. Edwards, W. Elliott, A. Elson, A. G. Engelbach, C. R. F. Englebach, R. Ewing, A. Eyles. E. Fairbrother, F. Fardon, R. Fendins, F. E. Fenier, R. C. Fenton, — Ferney, S. Ferguson, D. Fisher, H. E. Fowler, A. Francis, J. V. Franklin, A. Franks, T. W. Franks, F. Fraser, G. Fraser, J. J. Fraser, Capt. A. Frazer-Nash, B. S. Freeland, F. W. Fretton. D. Galloway, E. R. Gane, J. R. Garner, F. E. Gartside, G. Gaunt, C. D. Gay, F. Gent, H. J. Gibbons, L. J. Gibson, J. W. Gibson, A. A. Gilbert, S. Gilbert, J. Gilchrist, C. J. Glanville, F. O. Gloss, J. H. Goddard, R. C. Godfrey, J. S. Godman, A. Goldman, C. E. Gossling, J. Gourlay, C. E. Green, J. L. Green, N. Greenhalgh, H. G. Gregory, W. T. Griffiths, A. T. S. Groombridge, H. H. Groves. W. Hadley, G. H. Hales, R. W. Hall, F. W. Halliwell, C. Halse, E. Hammett, E. W. Hancock, D. A. Hannay, D. C. Harben, S. J. Harley, A. T. Harling, H. Harling, E. W. Harrington, E. T. Harris, A. Hart, R. Hazleton, H. W. Healey, H. Heath, J. C. Hendra, P. Hennessey, E. Hill, S. Hilliard, H. W. Hillman, W. C. Hindson, D. Hinton, W. V. Hodgson, G. Hogg, E. Holden, E. Holgate, R. F. Holland, S. J. W. Holt, G. R. Hook, J. Horridge, P. Horsfall, H. W. Horsman, E. R. Howlett, — Hudson, C. K. Hughes, H. S. Hull, W. G. Hunt, C. Hunter, H. Hunting, K. Hutchings, W. J. Hutchings. A. N. Jackson, K. S. Jewson, C. W. Johns, A. Johnson E. J. Johnson, L. W. Johnson, M. Johnson, E. J. H. Jones, E. S. Jones, Sidney Jones, C. R. Jordan, W. R. Joslin, T. E. Jowett, G. T. Joyce, S. Judd. C. Kaplin, P. Kasher, L. J. Kaye, W. Kean, T. G. Keep, T. Robinson Kidd, F. L. Kind, F. King, E. G. R. Kipps, G. R. Kipps, R. Kirchner, P. St. George Kirke, F. D. Kirkland, R. F. Knowlson. V. A. D. Lambert, H. E. Lane, J. B. Lang, A. L. Langdon, A. H. Langford, O. V. Langford, E. Langley, H. Lanstad, P. W. Laverick, G. V. Lawton, F. Lazenby, E. M. Lee, H. Leese, A. Leggett, C. W. Leng, A. R. Lewis, G. Lewis, K. C. Long, S. J. de. Lotbiniere, F. Maer, F. W. McCartney, R. H. McCartney, J. McDonnell, J. D. McFarlane, Major W. H. MacKenzie, P. MacKenzie, J. E. MacLaren, A. McLeod, Major General N. Macleod, Lt. V. Marmont, W. Marsden, R. W. Marston, S. A. Maskell, L. R. Mason, R. T. Mead, L. Meeson, H. Mc. L. Melville-Smith, T. G. Mercer, J. M. Meston, S. H. Miller, E. Mills, G. Mitchell, A. J. Mollart, J. E. Montgomrey, — Moore,

G. Moore, H. E.Moore, Dr. H. B. Morgan, W. J. Morgan, B. Morris, W.Mosey,J.Muir. G.W.Nash, A. Neaves, R. F. Newman, W. Newton-Booth, H. Nicholls, G. H. Nicol, D. B. Nivison, — Nixon, G. L. Norman, C. F. Norris, U. F. T. Norris, W. K. North, G. Norton, W. Nugent. F. A. Oakley, J. A. Oates, J. E. Oram. W. Paddon. H. R. Palmer, B. G. Parker, P. C. Parker, W. J. Parslow, A. Part, R. Pattinson, N. B. Peck, C. W. Pendry, R. Pentony, A. J. Percy, S. Perkins, Capt. R. C. Petter, H. Pettican, A. Phillips, E. J. Piggott, H. J. Ping, H. F.Plant, A. F. Flint, W. Puckey, F. A. Pucknell, H. Purdy. T. G. Quinney, F. W. Rankin, T. W. Ratcliffe, W. M. Ratcliffe, W. Reid, Major Gen. Guy. Riley, E. J. Ring, T. W. Roberts, W. T. Roberts, P. G. Robertson, F. C. Robinson, F. E. Robinson, J. Rose, H. Ross-Breher, L. Rumbold. Col. L. Sadler, R. Samson, G. B. Seauright, H. Scaife, Prof. Dr. G. Schlesinger, E. R. Schofield, A. Scroggs, Major J. H. Scrutton, A. Shaw, L. Shenton, F. W. Shoemack, H. A. Simmons, C. T. Skipper, H. E. Slawson, H. W. Smith, S. Smith, W. A. Smith, C. H. Sowerby, R. Spiller, W. H. Spivey, E. W. Sprott, G. C. M. Spry, J. Standring, P. J. S. Starr, L. S. Steinle, P. J. Stevens, E. C. A. Stinton, W. P. Stote, E. O. Stubbins, A. L. Stuchbery, C. Stucké, E. Swain, T. Sykes. H. Tauchert, A. L. Taylor, F. G. Taylor, H. Taylor, Mark H. Taylor, H. B. V. Teague, H. A. Thompsett, Capt. E. G. Thompson, S. M. Thompson, G. S. Thurley, W. A. Tomlinson, W. A. Tookey, J. H. Toothill, E. E. Tournier, — Townshend, W. L. Tregoning, S. H. Trigg, G. C. Trowbridge, L. Turner, C. G. Twallin, E. H. Tyler, W. H. Vernon, W. Wallace, J. Walters, Lt. H. Ward, H. H. L. Ward, W. E. Washbrook, D. M. Watkins, T. Watson, H. E. Weatherley, R. B. Webb, J. B. Webster, K. V. Webster, W. G. Weekes, J. C. Wegerif, D. C. L. Welsh, T. C. L. Westbrook, E. R. Weston, W. S. Weston, S. Westwood-Smye, F. B. White, F. C. White, L. Scott, White, E. Whitlock, Major R. X. Whitty, A. C. Wickman, E. W. C. Wilder, J. N. Williams, A. F. Williamson, W. C. Williamson, L. S. Wilson, G. E. Windeler, J. W. Woodger, T. N. Woof, H. T. Wordsworth, H. Wright, R. A. Wright, W. F. Wright, C. A. Wybron, A. Wynn. H. Yates, F. A. Young, F. C. Young, D. P. R. Yule. R. Zieschang.

After Luncheon the toasts of " The King," " The President of the French Republic," and " The President of the Polish Republic " were duly honoured.

The President, Mr. G. E. Bailey.

MR. G. E. BAILEY, M.I.P.E., M.I.Mech.E., President, in proposing the toast of " The Allies and Victory " said : My Lords and Gentlemen, It is a happy coincidence for me that my first duty as President of the Institution is to propose this important toast and to welcome you here this afternoon. This Luncheon is being held

in substitution of our Annual Dinner. We have invited you to this modest board in order that we might pledge the services of our members to the successful prosecution of the war, and from the speeches we are to hear we hope to receive some message that will spur them on to even greater efforts.

Our membership numbers now between 2,000 and 3,000. The purpose of our Institution, as you know, is to develop and promote the science of production engineering. We had hoped to be able to devote our energies to the arts of peace—improving manufacturing methods, developing the proper form of technical education for our younger members, and carrying on research activities made possible by the generous action of our Past-President, Lord Nuffield.

Now, however, that war has been forced upon us, the whole energies of our members are being devoted to the single aim of

INSTITUTION LUNCHEON

Left to right—**Mr. Burgin, the President, Hon. T. A. Crerar, Commander Lord Sempill, R.N.V.R.**

increased munitions production and necessary machinery and equipment, and the Institution is exerting every effort to facilitate their work and to assist the Government. The immense growth of mechanisation of every type indicates that victory in this war, even more than in the last, will depend on the engineer and on the production engineer in particular.

On behalf of the members I desire to assure Mr. Burgin that the production engineer will play his part to the full in the successful prosecution of the war, having adopted as his own, the motto in

the Coat of Arms of the Institution set out on the menu card before you—" Gathering strength as he goes." It would appear to me that this motto is very appropriate at the present time. But in war everything depends upon the speed at which one goes. The acceleration of our war programme must be at the highest rate possible, and to facilitate this we must know the maximum requirements at the earliest possible time. Fortunately, much good work was accomplished before the outbreak of war, and therefore to this extent we are better placed than in the last war. In this connection I would like to pay my tribute to the work accomplished by Admiral Sir Harold Brown as the Director General of Munitions Production at the War Office, prior to the formation of the Ministry of Supply. I understand that the Ministry of Supply is responsible for producing the specified requirements of the fighting services. They thus have a large share in the tremendous task of building up the most gigantic fighting machine of all time.

As engineers, we know that the successful functioning of any machine depends not only upon theory and practice, but upon the use of adequate factors of safety. Having in mind the tremendous wastage that must occur and the many unknowns that must be provided against, our knowledge as production engineers urges us to express the hope that the most liberal factors of safety will be used in arriving at the ultimate requirements of the various war materials comprising this great fighting machine upon which we confidently rely for ultimate victory.

And now I wish to assure Mr. Burgin of our appreciation of the magnitude of the task he has undertaken, of our confidence in him and his able staff to achieve success, of our loyal support, and, finally, our satisfaction at his presence here with us to-day.

We welcome the representative of France, Commandant Monod, of the French Mission, Ministry of Economic Warfare. In France we have an ally of our own choosing and of long standing. The Entente Cordiale, initiated by King Edward VII, has grown steadily stronger through many years of peace and war, and now we have arrived at the stage of unified control in war time. Our friendship and understanding is such that all the clumsy efforts of the enemy to cause dissension between us are doomed to failure.

We also welcome a representative of our gallant ally Poland, the Counsillor of the Polish Embassy. We desire to pay tribute to their great sacrifice and undying heroism against overwhelming odds. It will be our sacred duty to ensure that Poland rises again.

And, finally, we welcome our own kith and kin, the representatives of the Dominions of the British Empire. The participation of the Dominions in the direction of the war is a matter of great satisfaction to the British people, and is an indication of efficient co-ordination which is so necessary for that wholehearted co-operation

which will ensure victory. Gentlemen, I give you the Toast of "The Allies and Victory," coupled with the names of Mr. Leslie Burgin, Minister of Supply, and Mr. Crerar, Member of the Canadian Cabinet.

The Minister of Supply, Mr. Burgin.

THE RIGHT HON. LESLIE BURGIN, P.C., LL.D., M.P., Minister of Supply, in responding to the toast, said: Your Excellency, Commandant Monod, My Lords and Gentlemen, right thinking men and women throughout the civilised world will probably agree there is no more important toast that could be drunk at a gathering to-day than that of the toast to "The Allies and Victory." It is our unshaken belief that right is on the side of the Allies, that their cause is just and that, be the time short or be the time long, victory will crown the Allies in the end.

We fight for moral issues, not material ones, but although the issues themselves are moral, the organisation of the Allies to resist attack must be relentlessly material. If we are to inspire faith in our cause we must have behind us an active resolution to win, not merely a passive determination. In the midst of destruction we must be creative. Our liberty should be freedom to create, not merely licence to criticise shortcomings in others.

I derive some comfort from the fact that a production engineer is a creator, and that he fashions from metals taken from the ore bed and the mine substances that are useful, that can be put to good purpose, that will resist an aggressor and an invader and, when the tide of warfare turns, will enable the defender to counter-attack and press home his advantage.

I have just returned from three days in France where I had the opportunity of meeting the French Prime Minister, M. Daladier, members of his Cabinet and my opposite number, the French Minister of Munitions, M. Dautry. You production engineers here at this gathering to-day will salute your brethren from the other side of the Channel, whose problems are identical, whose tasks are vast, and whose needs are even more immediate, for they have a land frontier with Germany.

I visited munition factories, saw the night shifts, chatted with their personnel, inspected their A.R.P., suffered from the black-out, watched, in the course of actual raids on the French capital, their anti-aircraft defences at work.

The Allied Front is one and indivisible; the Allied cause is the cause of each of the Allies, and the supply of everything that goes to make an Allied victory possible is the prime purpose of the production engineer of this generation.

The production engineer is one of those rare types whose efforts for good or ill will make or mar—of course, in the case of members

of your Institution, will *make* and never mar. The difference between failure and success, under identical conditions, often comes back to the choice, wise or unwise, in the selection of the production engineer. Prodigies of output can be called, as it were, from the deep by some production engineers, whilst daily, weekly, monthly output from other shops does not show that steady upward graph so much to be desired. What power a production engineer wields ! Power under harness is magic, power not under control is disaster. A mountain waterfall—turbines at the foot, electricity generated—is an instance of water power under control contributing to the needs of mankind, but a roaring river that has burst its banks is an ugly sight, and as capable of dealing destruction as the river under control generating electric power is capable of providing warmth and light and heat and motive force.

INSTITUTION LUNCHEON
Viscount Nuffield and Mr. Leslie Burgin.

I am here to-day at your invitation to pay honour to your retiring President, Lord Nuffield, who, with his many organisations, is making such a powerful contribution to the rearmament of this land, and to give you in a few sentences some conception of the problem of supply.

The totalitarian war forced upon us by Germany demands the mobilisation of all our resources. It demands immense efforts for

the equipment of our Fighting Services. The responsibility for a large part of the organisation of this effort lies on my shoulders. It is my job to produce the munitions and equipment necessary for a vastly expanded Army—to produce them not only of high quality but in gigantic quantity. Such an effort must be carefully planned. It spreads over the Royal Ordnance Factories, large manufacturing firms, and, wherever practicable, over the small firms as well. Speed is the essence of the contract and if sub-contracting helps we readily use it.

For years tools have been collected, machines installed, skilled labour recruited, stocks built up, but modern continental war, when Germany is the attacker, is indeed a grim business, whose dimensions, extent and capacity for consumption stagger normal imagination. There is nothing half-hearted about the Allied preparation. We are conscious that the attack made by Germany upon Great Britain and France is as great as any attack that has ever been made in history by one nation on others. We are satisfied that our principal and immediate war aim, as the Foreign Secretary has so aptly described it, is to win the war. In our own country and in France normal business has been interrupted, an ever-increasing proportion of the manhood of the countries diverted from their normal tasks to purposes of defence, and this great national recruitment of man-power involves a corresponding call for equipment of these civilians with all the latest material which the General Staffs, with their experience, consider requisite.

The material the soldier wears and carries, the baggage train, no longer mule or horse-drawn, but mechanised, the weapons, offensive and defensive, to deal with attack from the air, attack by tank, attack from fortress, attack from the invading foe, ammunition to feed the guns and to feed at whatever rate those guns may be called upon to fire, tanks, all the requirements involved in those words " Division," " Corps," " Army," " Headquarters,"—this in terms of raw materials, of hours of labour, of tons of metals, of output of skill, of expenditure of money, of production of chemicals and explosives, of skilled fitting and assembly, means a picture of immensity which I am quite powerless adequately to convey. All I know is that in the week ending November 7, the amount in sterling of new orders placed by my Department of Government, the Ministry of Supply, was over £20,000,000 sterling, and that if we include firms dealing with clothing and equipment, 240 new firms became in that week alone new contractors to the Department. This means that since the outbreak of war, the Ministry of Supply alone has placed orders, with the approval of the Treasury, amounting to £160,000,000. The seventy-sixth day of the war, £160,000,000 expended by one Government Department alone! The simple arithmetic I leave to you. And to bring about this result, all this

miracle of creative effort, steered and guided into proper channels by production engineers, whether in the small shop, the larger works, the full-sized shadow factory or a royal arsenal, calls for the output of all classes of people in our land. It takes time to organise. There are inevitable disappointments because people offer their services and they are not at once absorbed, but I am convinced that the time is rapidly approaching when the entire output of the great mass of producers to the highest degree of their skill and their energy will be required for the defence of the state and the prosecution of the war.

In dealing with supplies, we have to ensure that there shall be a steady stream both of raw materials and finished articles to the right source at the right time, and for this purpose there has been established a priority machinery. This is doing effective work, less obtrusively than its predecessor in the last war, but equally effectively. It is all the time planning ahead, looking for bottlenecks and smoothing out difficulties. It is a machine which plays a large part in enabling us to take a long view of the problem of supply.

In all this field, co-operation is essential, between employers and employed—here we have a happy example—between contractors and sub-contractors, between controllers and producers and between Government Departments—but beyond all this is perhaps the most effective co-operation between ourselves and our Allies.

Our motto must be—" To the greatest extent possible we must equip the men overseas, the defence forces at home, the watchers of our shores and of our skies, and all the fighting services." The challenge we have to answer is the challenge of sufficiency. There must be and there shall be enough, and not only enough, but enough in the right place at the right time, by which I mean at the time it is most wanted. It is because underlying all these preparations the hearts of Frenchmen, Britishers and Poles are beating together, because the issues for which the Allies have gone to war are, as I said at the beginning, moral ones, that I am convinced perseverance, courage, sacrifice will bring victory in their train. " The Allies and Victory "—twin thoughts, a single aim ! Let us by our energy and by our example contribute each in his own measure our due share.

May I conclude, Mr. President, by wishing you a very successful period of office, by thanking you for the very great contributions which organisations under your direction are making, and by saluting you as a most worthy successor to Lord Nuffield himself.

The Hon. T. A. Crerar.

THE HON. T. A. CRERAR, Minister of Mines and Natural Resources, Dominion of Canada, who also replied to the toast, said : May I first thank the President and Council of the Institution of Production Engineers for their kindness in asking me to be present

on this occasion. A gathering of this kind is not unfamiliar to me. We have a similar organisation in Canada, perhaps of a slightly different character, known as the Institute of Mining and Metallurgy, and upon several occasions I have had the opportunity of speaking to them. That leads me to say a word or two about the development of our mining industry in Canada, and of the contribution, as a result of that development, which the Dominion is able to make to the great purpose we have now to face.

At the termination of the last war base metal mining in Canada had reached but comparatively small dimensions. In the last twenty years we have developed and expanded our production of copper, zinc, nickel, lead, and many other of the metals to a degree that no one at that time expected we would reach in the period that I have mentioned, and I pay tribute to the Canadians who were engaged in this great industry. I had the opportunity of meeting with them only a few days before I left Ottawa to come to London, and their main concern then was to increase their production to meet the need of the Allied cause in this struggle, and equally determined to do everything in their power to prevent any of the metals they were producing reaching enemy hands. Those steps have been taken voluntarily by these mining managers and executives, and they have co-operated in the closest and most effective way with the Canadian Government and will co-operate with the Allied Governments on this side to prevent any of these metals reaching enemy hands.

In other ways we are much better equipped to enter into the struggle than we were twenty-five years ago. Our national economy has improved. We will be able to do much in the way of financing the great effort and, so far as our factories are concerned, I think I can give you the assurance that they are very much better equipped to-day to produce all the things that are necessary in this vast mechanism behind our war effort. I can give you further assurance that all their effort will be directed whole-heartedly and effectively as they can make it to the great purpose in hand.

You may ask me, why is it that Canada is making such a great effort? From the peaceful farms of the Maritime Provinces, from the valley of the St. Lawrence, from the dales and hills of old Ontario, the prairies of Western Canada, and the Rockies, and the sunny slopes of the Pacific there is one unity of spirit and one determination, that Canada shall exert to the very maximum of her power her effort to put down the idea of force as the arbiter in international affairs. We are remote from the conflict in Europe. We do not expect that in this war our shores will be invaded, but we realise this, that if the ideas of totalitarianism now prevalent in certain great countries in Europe, if the ideas that international affairs shall be settled by force, that tyranny can impose its brute

heel upon Europe, then the ugly shadow of that is bound sooner or later to fall across our Dominion.

It is for that reason, and equally for the reason that we want to stand with the motherland in this struggle that Canada to-day is putting forth, and will put forth, the greatest effort that she is capable of making. And so we join with gallant France, with gallant Poland that has suffered so brutally in this struggle, with the gallant motherland in the gigantic effort she is making—we join with you all, willing to pool our resources to the utmost, that triumph of justice and right and liberty shall prevail, and in the words of the greatest President of the United States, we fight for this idea, that the people of the earth shall have the right to rule themselves in the way they think they should be ruled.

Commander The Lord Sempill, R.N.V.R., Deputy-President

COMMANDER THE, LORD SEMPILL, A.F.C., Deputy-President of the Institution, in proposing the toast of " The retiring President,

INSTITUTION LUNCHEON

Admiral Sir Harold Brown (*left*) **and the High Commissioner for Canada, Hon. V. Massey.**

Lord Nuffield " said : Mr. President, Your Excellency, Mr. Burgin, my Lords, and Gentlemen, Our Institution is fully alive to the great good fortune it has enjoyed in having the leadership and, as you all know, the very active support of one of the outstanding figures of our age, whose health I am to have the honour of proposing.

For two strenuous and critical years he has been our President, and though no longer in office now, he is continuing to serve as a Member of the Council of the Institution. Such an office is not a nominal one, and I need not tell you that our immediate Past-President is a Full Member and takes his full share of our work.

He knows well, as we all do, that our Institution was born of the storm and turmoil of the last war. Bitter experience proved that our country had not devoted nearly enough attention to the science of production engineering or to the problems of organisation bound up with its practice.

Are we to-day doing enough? I ask that question because I would like our immediate Past-President in the few words that we shall have the privilege of listening to in a minute or two's time, to say whether the official mind, in stressing so much the requirement of a University training for production engineers, is not making a mistake? I know that, due to the perspicacity of our guest of honour, Mr. Burgin, that condition has been temporarily set aside, but it never should have been laid down. There is no specialised education for production engineers at any of our universities, though such a course is to be found at Loughborough College. This Institution was formed and is controlled by men who have not had a university education.

I am particularly proud at this Luncheon to have the privilege of sitting between two gallant Scotsmen, Mr. Bruce, the famous Scots Australian, formerly Prime Minister and now High Commissioner of Australia, and Mr. Crerar, whom you have just heard, the famous Scots Canadian Cabinet Minister.

I want to give you too, if I may, a few words from my present chief, under whom I had the privilege of serving in the last war also, Mr. Winston Churchill. He fully appreciates the importance of the work of production engineers, and wants it to be known that the outcome that he visualises depends in his view very largely indeed on the effectiveness of their work.

Mr. Burgin has said very truly just what we expected him to say, and no one could say it better—that we are marching steadily and surely to victory. His words you have heard. I need not repeat them, but I repeat these words of Browning:

"One who never turned his back but marched breast forward.
Never doubted clouds would break,
Never dreamed, though right were worsted, wrong would triumph.
Held, we fall to rise, and baffled, to fight better."

For two years I have been in a privleged position in relation to our immediate Past-President and have acted as his shadow. He has been the centurian and I the common soldier, or perhaps I should say he is the Air Chief Marshal for Maintenance and Repair, and I the simple Aircraftsman. I will not, however, in his presence

make more than passing reference to all that he has done for our Institution, to his part in presenting us with the lease of our fine headquarters in Portman Square, and to the splendid foundation that he laid on which our Research Department has been built up. He will be pleased to know, that we have just appointed as Assistant Director of Research a young man of distinguished academic attainments, Mr. Donald Galloway, whose name alone is a sufficient password indicating that he comes from a country that has been accustime to produce engineers. Our distinguished Director of Research, Dr. Schlesinger, and he, are working at full pressure and contributing, we believe, very usefully to the national effort.

We are very proud of the fact that Lord Nuffield is remaining with us. We offer him our warmest congratulations on the highly important post that he has shouldered at the Air Ministry. I know you will drink his health with enthusiasm, and I give you the toast with these words: "Large was his bounty, and his soul sincere."

The Viscount Nuffield, Retiring President.

THE RIGHT HON. VISCOUNT NUFFIELD, O.B.E., F.R.S., M.A., D.C.L., LL.D., Director General of Mainteance, Air Ministry, retiring President, in responding to the toast, said: Mr. President, Lord Sempill, my Lords, and Gentlemen, I can first of all say that it is with regret I leave the presidency of this wonderful organisation, but my thoughts will always be with you, and anything I can do in the future to further your work will give me the greatest of pleasure. Before retiring I would like to thank Lord Sempill for the way he has helped me though my two years of office. As you will already know, I have been so busy that I could not attend many meetings, but I am sure you always felt that I have been with you. Anyway, I do want to thank Lord Sempill from the bottom of my heart for all he has done, and for all he has been trying to do for our Institution.

We have with us to-day Mr. Burgin, Minister of Supply. I am sure there is not a man in this room who does not agree that he is doing his best to see that everything that is possible is done to facilitate production, and not only to facilitate production, but to see that everything is done to win the war. I am sure that Mr. Burgin, and our friend Admiral Sir Harold Brown, his right-hand man, will do everything to help our members, who at any rate are doing most of the work in this country in the way of producing what is required. I do not know whether it is generally realized that the members in this room are to the greatest extent responsible for the materials of war that are being produced to-day. Without the production engineer I do not know where we should be, and when it is suggested that a university education is a necessary

qualification for production engineers entering Government service, I cannot understand why it should be required.

As I see things, and have seen things through my lifetime, the only way for a production engineer to get his qualification is through hard experience in business and the shops. Much as I think of a university education, I cannot see how such experience can be obtained in a university. I will go futher than that and say that in my opinion between the age of twelve and twenty our minds are as impressionable as a blotting pad. All the things I remember most clearly were gathered between the ages of twelve and twenty. Now, if at the age of seventeen or eighteen production engineers are going to a university, I would say that that time would be used to a far better advantage in business and in the shops.

I do not know whether I might include myself among production engineers. There are many cleverer men in this room to-day than

INSTITUTION LUNCHEON

Right Hon. S. M. Bruce (*left*), General Davidson, and Mr. E. Bruce Ball (President of the Institution of Mechanical Engineers).

I am in production engineering, and I want you to realise that. I had no teaching as an engineer. I started for myself at the age of fifteen. I had from that time onwards to glean what I could gather to carry on business, but it does emphasise what I have been saying, that especially between the age of fifteen and twenty most boys' time will be far better spent at the job they will be doing for the rest of their lives. I suppose if I had a son I would give him a public school education, first of all for the sake of discipline, which without a doubt is admirably taught in the public schools of

this country. Then, if he were going for any of the learned professions I will say without fear of contradiction that a university education was absolutely essential. But if he were going to be a production engineer, definitely, no.

I am pleased to see several visitors here to-day from the Dominions overseas. I have travelled as much as any other man in this country, and I can assure you that when I go to those great Dominions I am always received with the greatest friendliness. From the number of times I have visited them I have got to understand their mentality, and I am sure their understanding of ours is always increasing. We have to realise that we live in most cases a very long way apart, and I think it is up to every manufacturer in this country to see that he sends some member of his organisation overseas at least once a year, and that countries abroad should reciprocate. We will better understand one another the more we meet. It would be an advantage if our great organisations in this country did more to encourage that friendly feeling of brotherhood which should exist, and does exist in a way, but which can be much more greatly emphasised by meeting and talking over our various difficulties.

Now, gentlemen, I want to thank you very much for listening to me so long. I am sure that this Institution will go ahead in leaps and bounds, to the great benefit of this country in general and particularly to that of the Government. Once again I want you to feel that if anything of consequence arises you can put it up to me and I will do my best to help you at all times.

The President.

The toast of "The President" was then given by the Deputy-President.

MR. BAILEY, President, in replying, said: Lord Sempill and Gentlemen, I wish to thank you very much for this toast and the way in which you have responded to it. I know you appreciate that Lord Nuffield has been an excellent President, but I ask you to appreciate that from my point of view he is a very difficult man to follow. I feel very much the honour which the Institution have done me as a member in electing me President. Unfortunately, to-day time does not allow me to refer to any matters which are so important to the production engineer and in which we have common sympathy, but I hope on a future occasion when we meet under happier conditions that we shall be able to talk on them.

I appreciate the many difficulties with which the production engineer has to contend at the present time. In my speech there was one matter, very close to my heart, to which I should have liked to refer but which normally would not come under the activities of this Institution. Still, it is one which is of the greatest

importance to many of our members. I refer to the question of labour. Many of our members are controlling large bodies of workpeople at the present time, and when the activities of the Ministry of Supply and other departments necessitate the erection of factories and equipping them with the necessary machinery it is often overlooked that all these efforts are in vain if this equipment is not manned by efficient labour.

One of the difficulties that the production engineer has to contend with at the present time is this question of the continuous drain of the men on which he has to rely to keep the promises to which he is committed. I suggest that the Government see to it, particularly those who are responsible for production like Mr. Burgin, that the proper people are available for the production engineer to carry out his obligations. I have attended meetings and very worthy representatives of the Government have attended, but one comes away with the definite feeling that the people who are representing the Government are representatives of the fighting services and the Ministry of Labour. The people in the Government who ought to be responsible are those who have obtained commitments from the production engineer. I feel that having placed these large contracts it is up to them to ensure that we have the necessary supply of labour, and the only way that I know of is for them to take a personal interest and see that they are properly represented on these committees.

Further, in connection with this question of labour, I have spent many years negotiating with Trade Unions, and I feel that it is only fair that I should state that at no time in my experience have the relations between official Trade Union leaders and employers in the engineering industry been on a more friendly basis. We have been able to obtain a concession in regard to dilution, as you know, and we confidently hope that we shall be able to obtain more concessions. Now these concessions can only be obtained by sympathetic consideration on both sides. This war is going to be won by co-operation—co-operation of every class in the British Empire and France.

Now, one more question in connection with labour. We start this war definitely with much happier relations between the employer and labour than we did on the last occasion. To my mind, there is no question whatever that the large majority of the workpeople of this country are out to win this war. We must do everything posible to retain this spirit, and I do feel that all those who are handling labour should exercise the greatest possible care in seeing and ensuring that the minor troubles that occur and which inevitably will occur, particularly with new labour, are dealt with quickly and efficiently, so that they do not grow into serious troubles. In this way you will be helping those who have to deal with these

troubles when they become serious. Those of us who have had to negotiate have always relied upon the knowledge of those in charge of labour, and, within the provisions for avoiding disputes which we have framed with the Unions, we have particularly specified the first stages in handling any dispute will be in the shop, where the trouble occurs. That is indicative of the trust that we have in management, and we know that that trust will be respected and that everyone will do all possible to ensure the friendly relations with labour which are so necessary. I thank you.

Presentation of Awards.

Prior to Lord Nuffield's speech, the President, MR. BAILEY, presented to the recipients the following awards :

MEDAL FOR BEST PAPER BY A MEMBER : C. W. Leng, Esq., A.M.I.P.E., for his paper on " Spot Welding."

MEDAL FOR BEST PAPER BY A NON-MEMBER : E. R. Gadd, Esq., M.Inst.Met., for his paper on " Heat Treatment of Materials."

MEDAL FOR BEST PAPER BY A GRADUATE (Hutchinson Memorial Medal) : C. K. Hughes, Esq., Grad.I.P.E., for his paper on " Factory Organisation in Germany."

THE LORD AUSTIN PRIZE : R. W. Marston, Esq., Grad.I.P.E., for his attainments at the 1939 Graduateship Examination.